CLAIMS

1. An optimizing method that optimizes, using a computer, a component mounting order in which a mounter equipped with a mounting head picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board,

wherein the mounting head has, at maximum, L pickup nozzles for picking up the components, L being no less than 2, and

a plurality of components to be optimized include plural types of components which are picked up using no less than 2 pickup nozzles of different types, and

the optimizing method comprising:

a nozzle set determination step of determining a nozzle set for mounting all the plurality of components with a smallest task number, where a nozzle set is a combination of pickup nozzles to be attached to the mounting head and a task is a group of components to be mounted by one iteration of the repeated series of processes where the mounting head picks up, transports, and mounts components; and

a mounting order determination step of determining the array order of component feeders and the component mounting order, while maintaining the determined nozzle set.

2. The optimizing method according to Claim 1,

wherein the pickup nozzles attached to the mounting head are interchangeable, and

in the nozzle set determination step, a nozzle set is determined, said nozzle set reducing a mounting time in view of the number of times interchanging the pickup nozzles for mounting the components and a total number of tasks.

3. The optimizing method according to Claim 2,

wherein in the nozzle set determination step, i) at least one kind of nozzle set is specified, said nozzle set corresponding to the number of times interchanging the pickup nozzles, ii) the task number for mounting the plurality of components is calculated using the specified nozzle set, iii) a combination of the number of times interchanging the pickup nozzles and the calculated task number is estimated, and iv) the nozzle set is determined as a result of the estimation.

4. The optimizing method according to Claim 3,

wherein the nozzle set determination step includes:

a task number calculation step of repeating the processing of calculating the task number for mounting the plurality of components using "n" kinds of nozzle sets, "n" being no less than 1, while incrementing the "n" by 1; and

a nozzle set number specification step of calculating an evaluated value S corresponding to the mounting time according to a predetermined evaluation function, specifying "n" kind of nozzle set corresponding to a combination in which the evaluated value S is the smallest, and determining the specified "n" kind of nozzle set as the nozzle set.

5. The optimizing method according to Claim 4,

wherein the task number calculation step includes the following steps:

calculating a task number for a case in which the plurality of components are mounted on a board, using the mounting head on which L components are picked up as many as possible, as a minimal task number; and

judging for each task number whether or not it is possible to mount all the plurality of components by incrementing the calculated minimum task number by 1, and obtaining a minimum

task number that is judged as possible as the task number for mounting all the plurality of components using "n" kinds of nozzle sets.

6. The optimizing method according to Claim 5,

wherein in the task number calculation step, a task number of a nozzle set is incremented, said task number of the nozzle set, out of a plurality of nozzle sets determined immediately before, having fewer "empty head" which is a state in which a mounting head is empty when performing a task for components fewer than the number L.

7. The optimizing method according to Claim 5,

wherein the task number calculation step further includes calculating the task number by decrementing the calculated minimum task number by 1.

8. The optimizing method according to Claim 7,

wherein in the task number calculation step, the task number is decremented, said task number of the nozzle set, out of plural nozzle sets determined immediately before, having more "empty head" which is a state in which a mounting head is empty when performing a task for components fewer than the number L.

9. The optimizing method according to Claim 4,

wherein the number of usable pickup nozzles is restricted depending on the type of pickup nozzles, and

in the nozzle set determination step, when the "n" kinds of nozzle sets are respectively determined, a combination of a pickup nozzle and the number of components to be mounted using said pickup nozzle is specified for the number L or fewer within the restricted range.

10. The optimizing method according to Claim 4,

wherein in the task number calculation step, the possible combinations for the task numbers calculated using the respective "n" kinds of nozzle sets are extracted, whether or not it is possible to mount all the plurality of components is sequentially judged for all the extracted combinations, and a minimum task number that is judged as possible is obtained as the task number for mounting the plurality of components using "n" kinds of nozzle sets.

11. The optimizing method according to Claim 10,

wherein in the task number calculation step, the combinations are extracted from a restricted range specified by minimum and maximum task numbers, said minimum task number is a task number for mounting the plurality of components on a board as many as possible, using a mounting head by which L components are picked up, and said maximum task number is the number of components having the largest number out of the components classified based on the type of pickup nozzles.

12. The optimizing method according to Clam 4,

wherein the task number calculation step includes:

a first calculation step of: calculating a task number for a case in which the plurality of components are mounted on a board, using a mounting head on which L components are picked up as many as possible, as a minimal task number; judging whether or not it is possible to mount all the plurality of components for each task number by incrementing the calculated minimum task number by 1; and obtaining a minimum task number judged as possible as the task number for mounting the plurality of components using "n" kinds of nozzle sets;

a second calculation step of: extracting the possible combinations for the task numbers calculated by using the

respective "n" kinds of nozzle sets; judging sequentially whether or not it is possible to mount all the plurality of components for all the extracted combinations; and obtaining a minimum task number judged as possible as the task number calculated using the "n" kinds of nozzle sets; and

a selection step of executing selectively either the first calculation step or the second calculation step.

13. The optimizing method according to Claim 2,

wherein in the nozzle set determination step, a nozzle set which obtains the smallest evaluated value S is determined as the nozzle set that reduces a mounting time, said smallest evaluated value S is calculated using $S=X+ h \cdot N$, where N indicates the number of times interchanging the pickup nozzles, X indicates the total task number, and h indicates a coefficient for converting the time taken by interchanging the pickup nozzles into a task number.

14. The optimizing method according to Claim 2, further comprising a nozzle pattern determination step of determining a nozzle pattern in which a type of pickup nozzle is assigned to each of a plurality of heads composing the mounting head for all the tasks for mounting the components, while maintaining the nozzle set determined in the nozzle set determination step,.

15. The optimizing method according to Claim 2,

wherein the mounter includes a nozzle station at which the pickup nozzles are arranged, and

the optimizing method further comprises a nozzle station arrangement determination step of determining a combination of a type of nozzles to be arranged at the nozzle station and a place for the arrangement based on the nozzle set determined in the nozzle set determination step.

16. The optimizing method according to Claim 2,

wherein in the mounting order determination step, the components are classified into small components and general components based on heights of components, the array order of the component feeders and the component mounting order for the small components are determined so that the number of components to be picked up per task by the mounting head increases while the array order of component feeders and the component mounting order for the general components are determined in a search of a mounting order which reduces the mounting time while switching the order of mounting components.

17. The optimizing method according to Claim 1,

wherein in the nozzle set determination step, the nozzle set and the task number are determined, said nozzle set for mounting all the plurality of components with the smallest task number, without interchanging the pickup nozzles attached to the mounting head.

18. The optimizing method according to Claim 17,

wherein the nozzle set determination step includes:

an initial nozzle set calculation step of calculating the number of pickup nozzles for each type as an initial nozzle set based on the number of components to be picked up respectively by different types of pickup nozzles;

an initial task number calculation step of calculating a total task number for mounting all the plurality of components based on the number of components corresponding to the calculated initial nozzle set;

a task number calculation step of calculating a total task number when the number of pickup nozzles is incremented or decremented by 1 for each type of the initial nozzle set; and

a judgment step of judging whether or not the total task number calculated in the task number calculation step is smaller than the total task number calculated in the initial task number calculation step, and when the former is smaller than the latter, the judgment on whether or not the decremented or incremented total task number becomes smaller after the incremented or decremented nozzle set has been updated as a latest nozzle set, and when the former is not smaller than the latter, the previous nozzle set and the total task number for said nozzle set are determined as the initial nozzle set and task number.

19. The optimizing method according to Claim 18,

wherein the respective plurality of components belong to one of a plurality of component groups classified based on heights of components, and

the task number calculation step includes:

a component group task number calculation step of calculating a task number for mounting all the components belonging to each of said component groups; and

a total task number calculation step of calculating a total task number by totaling each of the task numbers calculated in units of component groups.

20. The optimizing method according to Claim 19,

wherein in the component group task number calculation step, when a component group includes plural types of components to be picked up using a plurality of pickup nozzles, a maximum task number, out of task numbers corresponding respectively to the plurality of pickup nozzles, is obtained as a task number of the component group,.

21. The optimizing method according to Claim 1 further

comprising:

a component group allocation step of allocating the plurality of components to two or more mounters in units of component groups so that task numbers at the two or more mounters is averaged, when a task is a group of components to be mounted by one iteration of the repeated series of processes where the mounting head picks up, transports, and mounts components; and

a component moving step of modifying the allocation by moving a part of components allocated to a mounter with a larger task number to a mounter with a smaller task number so that all the allocated components are mounted without interchanging the pickup nozzles attached to the mounting head and the task numbers for the two or more mounters is averaged.

22. The optimizing method according to Claim 21,

wherein in the component group allocation step, processing of modifying the allocation by moving sequentially the component groups allocated to the mounter with a larger task number to another mounter that is connected adjacently to said mounter after having allocated all the component groups to the two or more mounters so that the component groups of low components are allocated to a mounter positioned upstream in a production line is repeated until a size relation between the task numbers for the two mounters reverses, and when the size relation is reversed, the previous state in which the component groups are allocated is determined as a final state.

23. The optimizing method according to Claim 21,

wherein in the component moving step, components to be moved are determined based on a difference between the task numbers at the respective two or more mounters for mounting the components allocated in the component group allocation step, and

the determined components are moved.

24. The optimizing method according to Claim 23,

wherein in the component moving step, when a component such that requires a new pickup nozzle is moved from the second mounter to the first mounter, a space for the new pickup nozzle is retained by determining a pickup nozzle with which a task number becomes the smallest, out of a plurality of pickup nozzles assigned to a first mounter, said task number being incremented by decrementing the number of pickup nozzles by 1.

25. The optimizing method according to Claim 1 further comprising:

a nozzle allocation step of determining types and numbers of pickup nozzles for respective two or more mounters according to types and numbers of components allocated to the respective two or more mounters;

a task number calculation step of modifying the number of pickup nozzles determined in the nozzle allocation step based on a restriction on nozzle resource number that is the number of usable pickup nozzles, and of calculating a task number at each mounter, the types and numbers of pickup nozzles for mounting all the components allocated to each mounter without interchanging pickup nozzles, based on the number of pickup nozzles after the modification and the corresponding number of components; and

a nozzle number adjustment step of incrementing or decrementing the number of pickup nozzles allocated to each mounter so that a difference between the mounters in task numbers calculated in the task number calculation step is reduced.

26. The optimizing method according to Claim 25,

wherein in the nozzle number adjustment step, a difference

in task numbers between the first and second mounters is reduced by incrementing the number of pickup nozzles allocated to the first mounter with larger task number by the number "n" and decrementing the pickup nozzles allocated to the second mounter with smaller task number by the number "n", when the pickup nozzles of the same type are allocated to the first and second mounters.

27. An optimizing apparatus that optimizes, using a computer, a component mounting order in which a mounter equipped with a mounting head picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board,

wherein the mounting head has, at maximum, L pickup nozzles for picking up the components, L being no less than 2, and

a plurality of components to be optimized include plural types of components which are picked up using no less than 2 pickup nozzles of different types, and

the optimizing apparatus comprising:

a nozzle set determination unit operable to determine a nozzle set for mounting all the plurality of components with a smallest task number, where a nozzle set is a combination of the pickup nozzles to be attached to the mounting head and a task is a group of components to be mounted by one iteration of the repeated series of processes where the mounting head picks up, transports, and mounts components; and

a mounting order determination unit operable to determine the array order of component feeders and the component mounting order, while maintaining the determined nozzle set.

28. A mounter equipped with a mounting head which picks up, at maximum, L components, L being no less than 2, from an array of

component feeders that hold components, and mounts the components on a board,

wherein the components are mounted in an order of mounting components, optimized by the optimizing method according to Claim 1.

29. A program for an optimizing apparatus that optimizes, using a computer, a component mounting order in which a mounter equipped with a mounting head picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board, the program causing the computer to execute the steps included in the optimizing method according to Claim 1.

30. A computer-readable storage medium on which a program according to Claim 29 is recorded.